
The background of the slide is a faded, sepia-toned photograph. It depicts a Chinook helicopter on a grassy field with its rotors blurred, suggesting it is in motion. Several soldiers in military uniforms are visible around the helicopter, some standing and others in a more active posture. The overall scene is hazy, giving it a historical or archival feel.

Soldier Focused Logistics

“Transforming the Chinook”

A Team Redstone Initiative



The State of Aviation Maintenance



- Continuously Increasing System Complexity.
- Cumbersome Update Process for Tech Data.
- Lack of “At the Aircraft” Information (field data).
 - Existing data collected “on the backs of the soldiers”
- Increasing Maintenance Burden (Aging Aircraft).
- Scheduled Maintenance Creep.
- Continuous Pressure to Downsize Support Structure.
- Corporate Memory erosion (expertise).
 - FHP, Retention, Development, Retirement
- Training Dependent on OJT in Reduced FH Environment.





Transforming the Chinook- the Vision

To provide best-in-class weapon system support that off-loads the Soldier, meets the logistics transformation goals, and affords the warfighter an unprecedented capability to manage their combat systems and accurately predict a true "Go-to-War" capability.

A major tenet of this effort is continuous evaluation and improvement, focused on the soldier. The three top priorities of this transformation are:

- Reduce the burden on the soldier*
- Reduce the burden on the soldier*
- Reduce the burden on the soldier*

OSD VE
Pilot

CH-47F

RCM2

AMAC

Engine
Testability

Recapitalization

SF
L

OSD UID
Pilot

DLA SSA
Pilot

OSD JDSR
Pilot

714A
Engine

912(c)
Pilot

DAU
Log 206
Model

Extended
400 hr Phase



The Starting Place - The Aircraft



- All Costs Start at the Aircraft.
- Total Cost is $\Sigma(M_E \cdot C_{ME})$.
- Total Downtime = $\Sigma(M_E \cdot DT_{ME})$.
- Real improvement occurs only when M_E , C_{ME} or DT_{ME} are reduced and are measurable.

Definitions:

M_E - Maintenance Event.

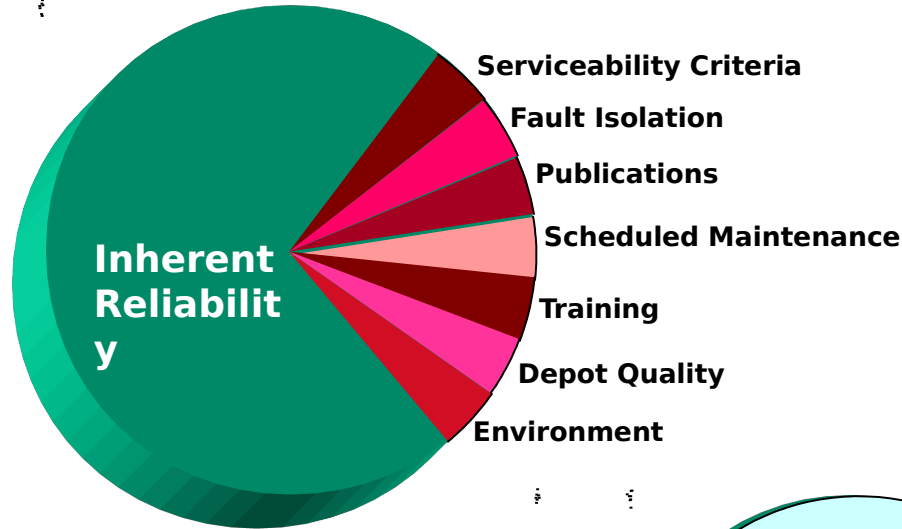
C_{ME} - Cost Per Maintenance Event.

DT_{ME} - Downtime per Maintenance Event.

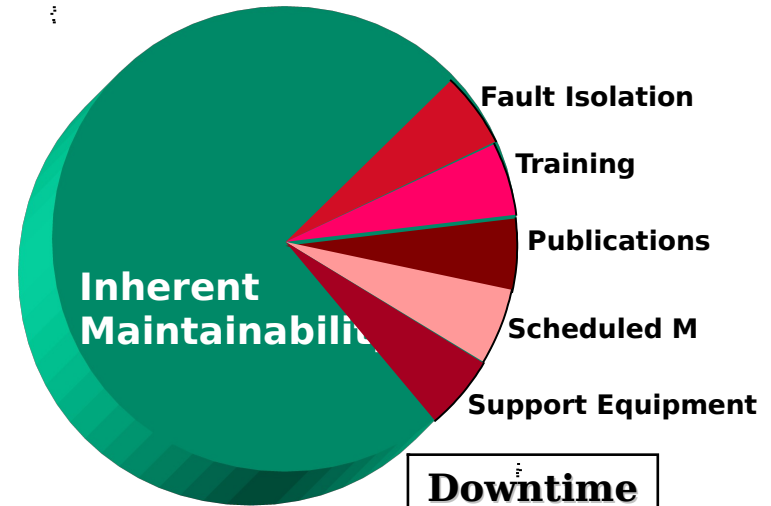




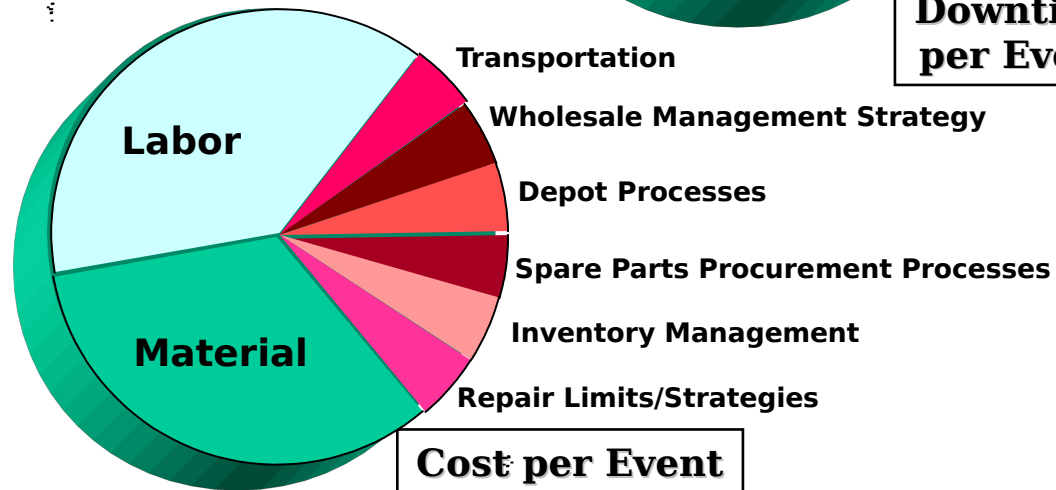
What Drives Cost and Downtime?



Maintenance Event Frequency



Downtime per Event



Cost per Event

Non Hardware issues are just as important as Hardware issues



The Challenge...

Understanding Component Level Contributions to System Support Costs and Readiness

- **No Current Data System Gives Insight Below Top Level for**
 - **Cost ... OSMIS**
 - **Readiness ... 1352**

Directed at
Magnitude ... Not
Cause

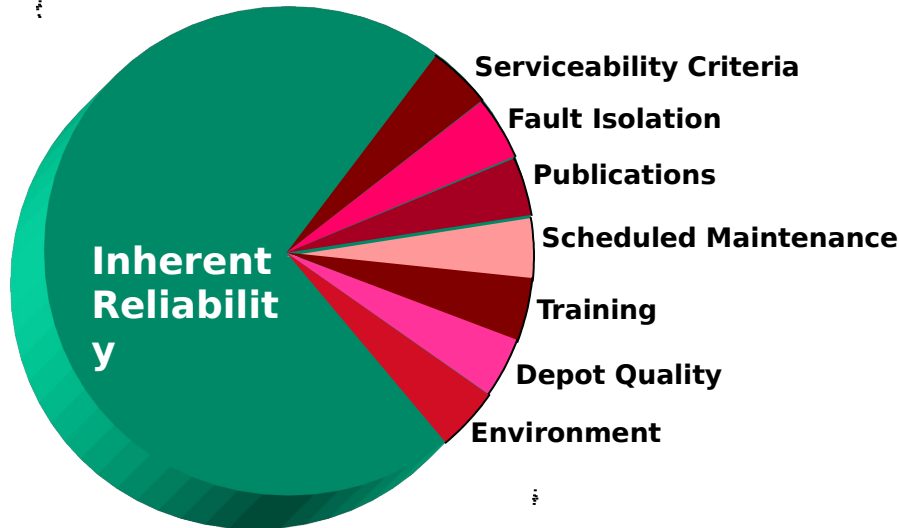
- **Lack of 2nd Level of Detail Results in Suboptimization of**
 - **Maintenance Support Strategies.**
 - **Ill-Conceived O&S Cost Reduction Initiative.**
 - **Inefficient Wholesale Logistics Practices.**
 - **Inability to Establish Total Life Cycle Management Per**

We Have to “Manage With the Force of Facts*”

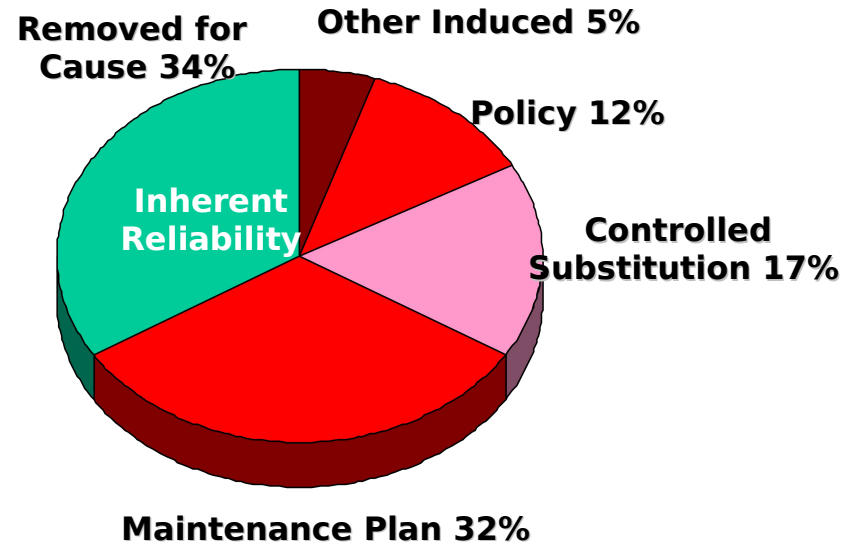
*Bill Gates, Business @ The Speed of Thought” 1999



What Causes Aviation O & S Costs



Maintenance Event Frequency



Removal for Cause: Operational Malfunction/Failure.

Maintenance Plan: Scheduled Removal, Time Change, Retirement.

Controlled Substitution.

Policy: MWO, SOF, ASAM, Removal per DMWR.

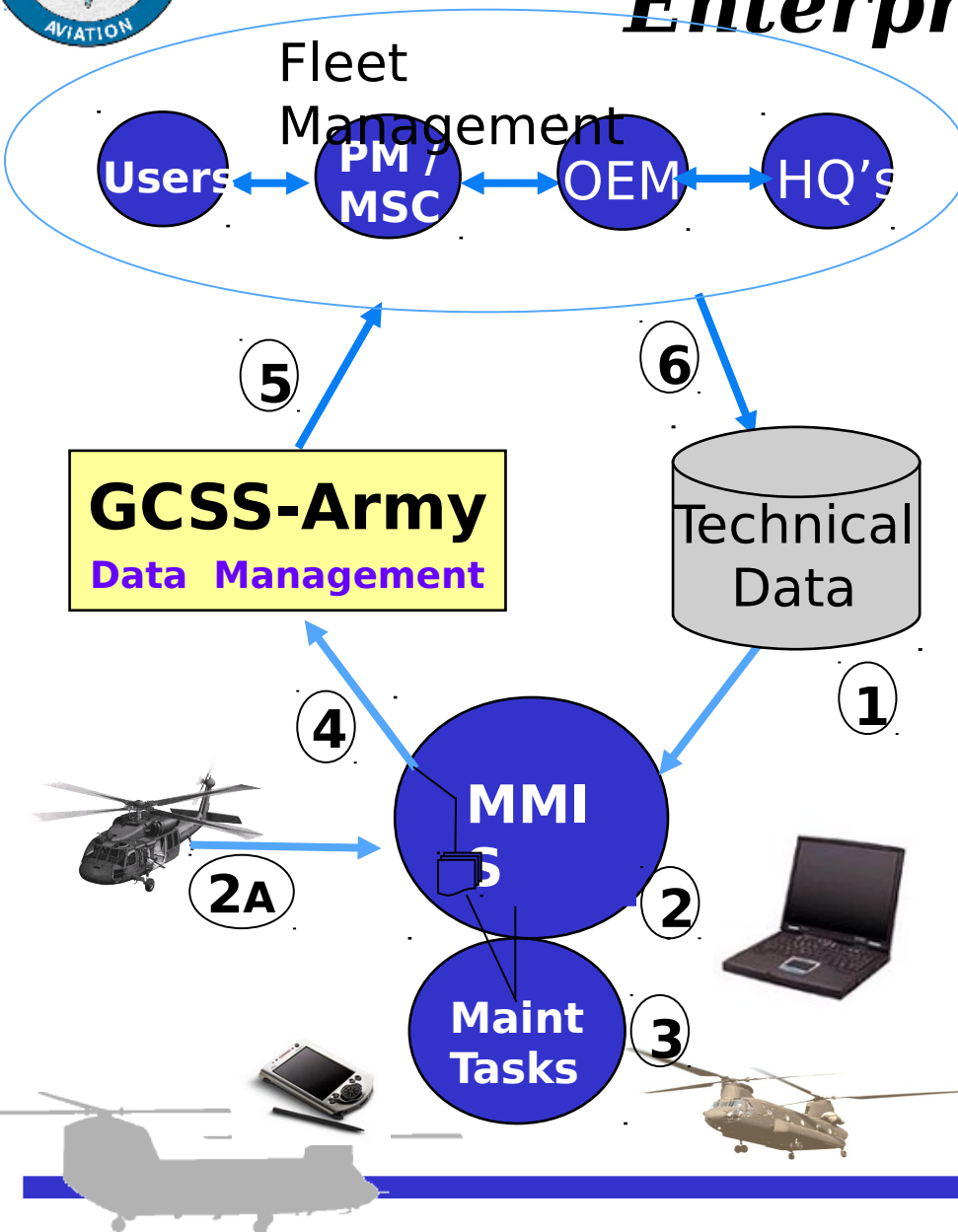
Other Induced: Mission or Environment Induced.

Aggregate of all 2410 Components





How does AMAC Operate w/in Enterprise?



Closed-Loop System

Step 1 - Technical Data is maintained in a central database. Changes are transmitted to the MMIS at the user location.

Step 2 - The MMIS assembles technical data in card format or interfaces with an IETM.

Step 2A - On-Board system provides Health and Usage Data to MMIS.

Step 3 - Maintainer performs maintenance and "documents" via electronic card or IETM through MMIS.

Step 4 - The MMIS provides local management capabilities and sends field data to GCSS-Army.

Step 5 - Fleet Management: Data is accessed and analysed, by PM, User, Higher headquarters, OEM and other stakeholders.

Step 6 - Two way communication permits feedback from fleet level.

Task Frameset - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back

Search

Favorites

Media

Address <http://localhost/ecard/ecard/taskframe.asp?intMWO=8&intPartScreen=8&intASN=8&strParentTaskID=8&strArisingTaskID=8&strTaskID=AAAR07AAHAAAL1LAAO&intStepNumber=1&intSelStart=20&intSelEnd=60&st> Links >>

CH47 E-CARD PROTOTYPE

TASK LOCATION

AIRCRAFT TAILNUMBER

ASN / ARISING CODE

STATUS

SELECTED TASK

Remove Fwd Rotary-wing Head

FIRST 20 LAST 60 GO SIGN COUNTERSIGN ENLARGE

TASK STEPS

STEP CHECK TRAINING

DESCRIPTION

▶ 22 ☐

▶ 23 ☐

▶ 24 ☐

▶ 25 ☐

▶ 26 ☐

▶ 27 ☐

▶ 28 ☐

▶ 29 ☐

Position socket (T29) (30) on hub retaining nut (31).

NOTE

For forward head, install adapter with marking FWD ROTOR THIS SIDE UP on top. For aft head, install adapter with marking AFT ROTOR THIS SIDE UP on top.

Install reaction adapter (T28) (32) as follows.

Secure three reaction hooks (33) to adapter (32), with REMOVAL side out. Use bolts (34).

Position adapter (T28) (32) on top of head (1) with reaction hooks (33) against caps (35) and with handwheels (36) on top.

CAUTION

Do not over-tighten handwheels; otherwise, damage to rotor hub or adapter can occur.

Position three clamps (37) under top flange (37.1) of head (1). Tighten handwheels (36).

Install torque applicator (T2) (38) and tee handle (T161) (39) on reaction adapter (T28) (32). Turn handle, if required, to rotate applicator to engage reaction pins (39.1) in adapter.

CAUTION

Do not use power tools to turn torque applicator. Applicator could be severely damaged.

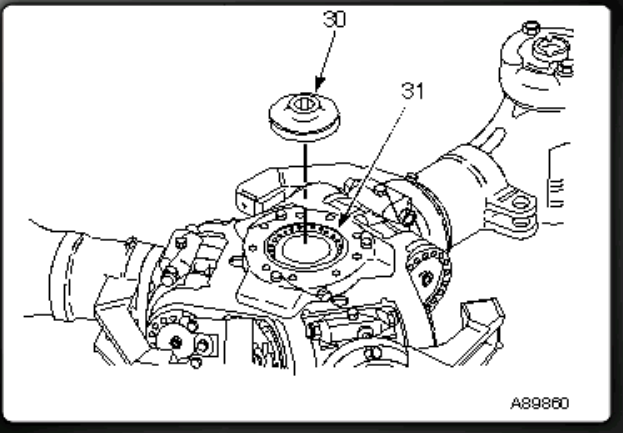
NOTE

Pins under torque applicator must be fully seated in reaction adapter (T28) to prevent applicator ride-up when torque is first applied.

Turn handle (39) counterclockwise until nut (31) is loose.

Continue to loosen nut (31) until torque drops to near 0 foot-

Step 22 ◀ Image 1 of 1 ▶



ENLARGE

TASK SUMMARY

MAKE A COMMENT

COMPLETE TASK

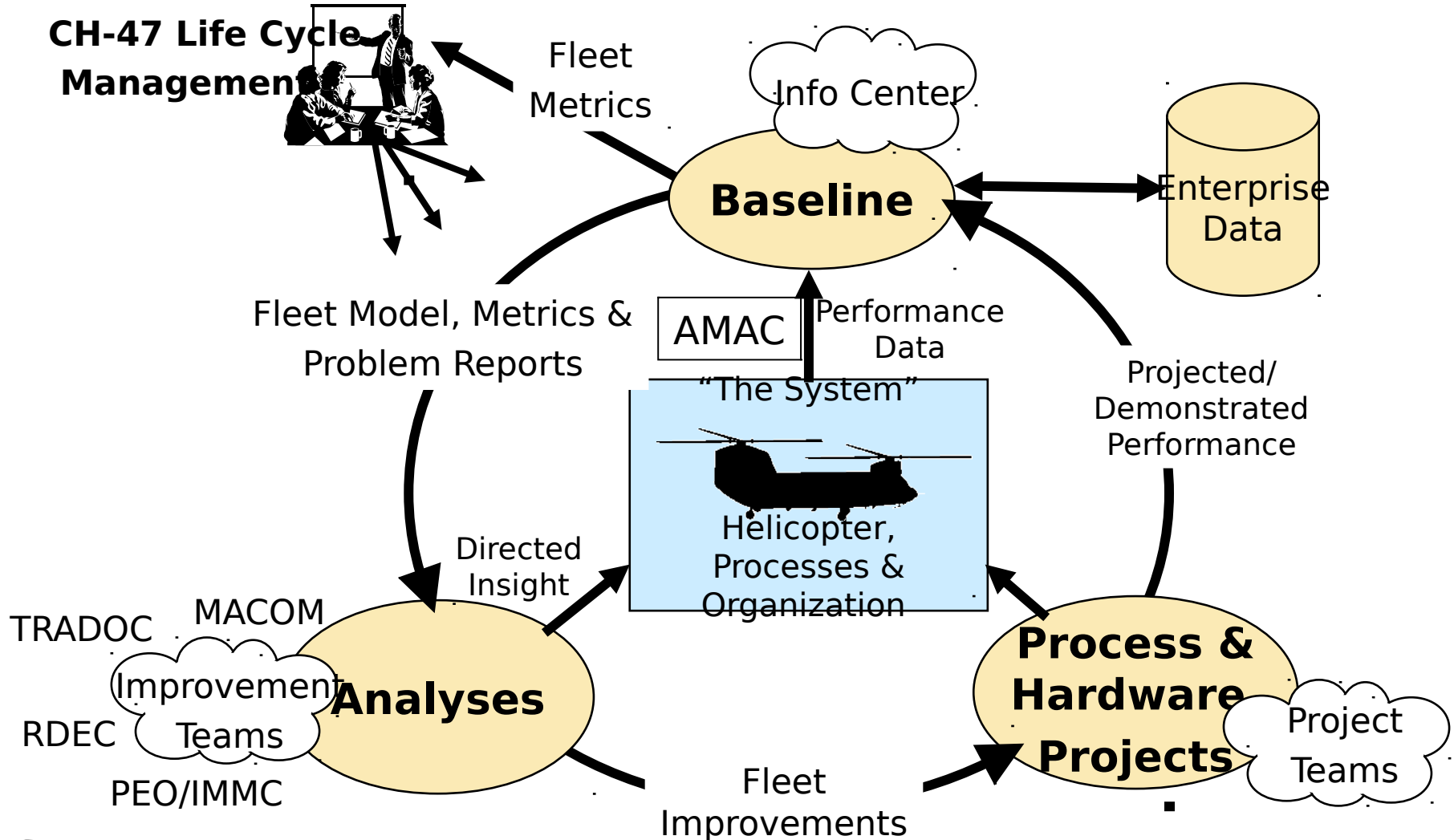
RECORD ASSOCIATED FAULT

Done Local intranet



Cargo LCM Process

CH-47 Life Cycle Management



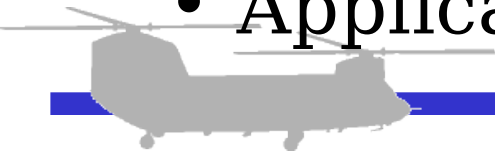
CH-47 Focused

Logistics

Phase 1 - Process Re-engineering



- Build on CH-47 Life Cycle Management Concepts.
- Re-engineer LCM processes...
 - From historical "Readiness" - Static, based on historical averages
 - To predictive "GO-to-WAR" - Sustained capability from future projections
- Drive Process Change Through Shared Metrics.
- Meet DA/OSD Goals (Readiness/TOC).
- Applicable to Entire Weapon System.

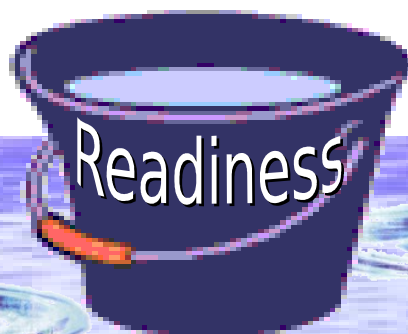
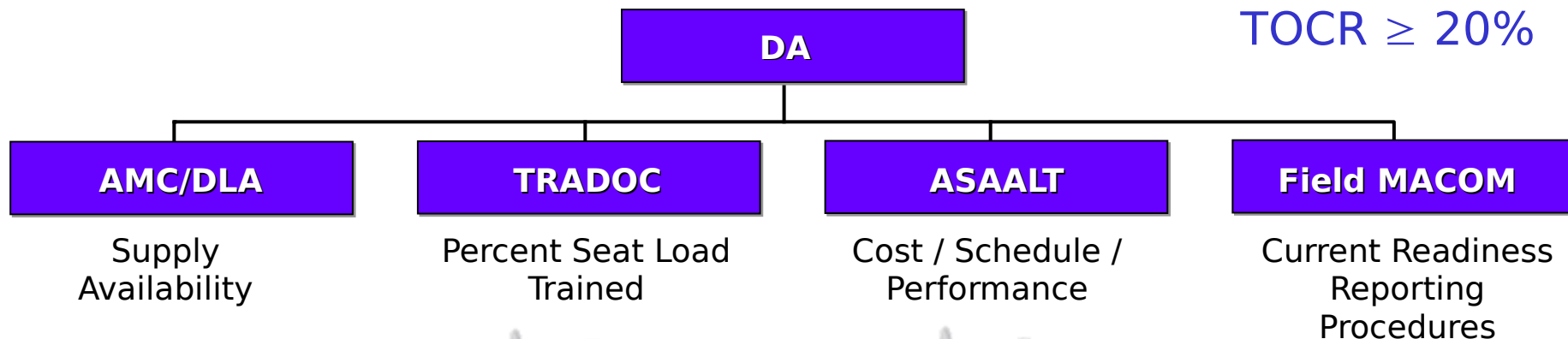




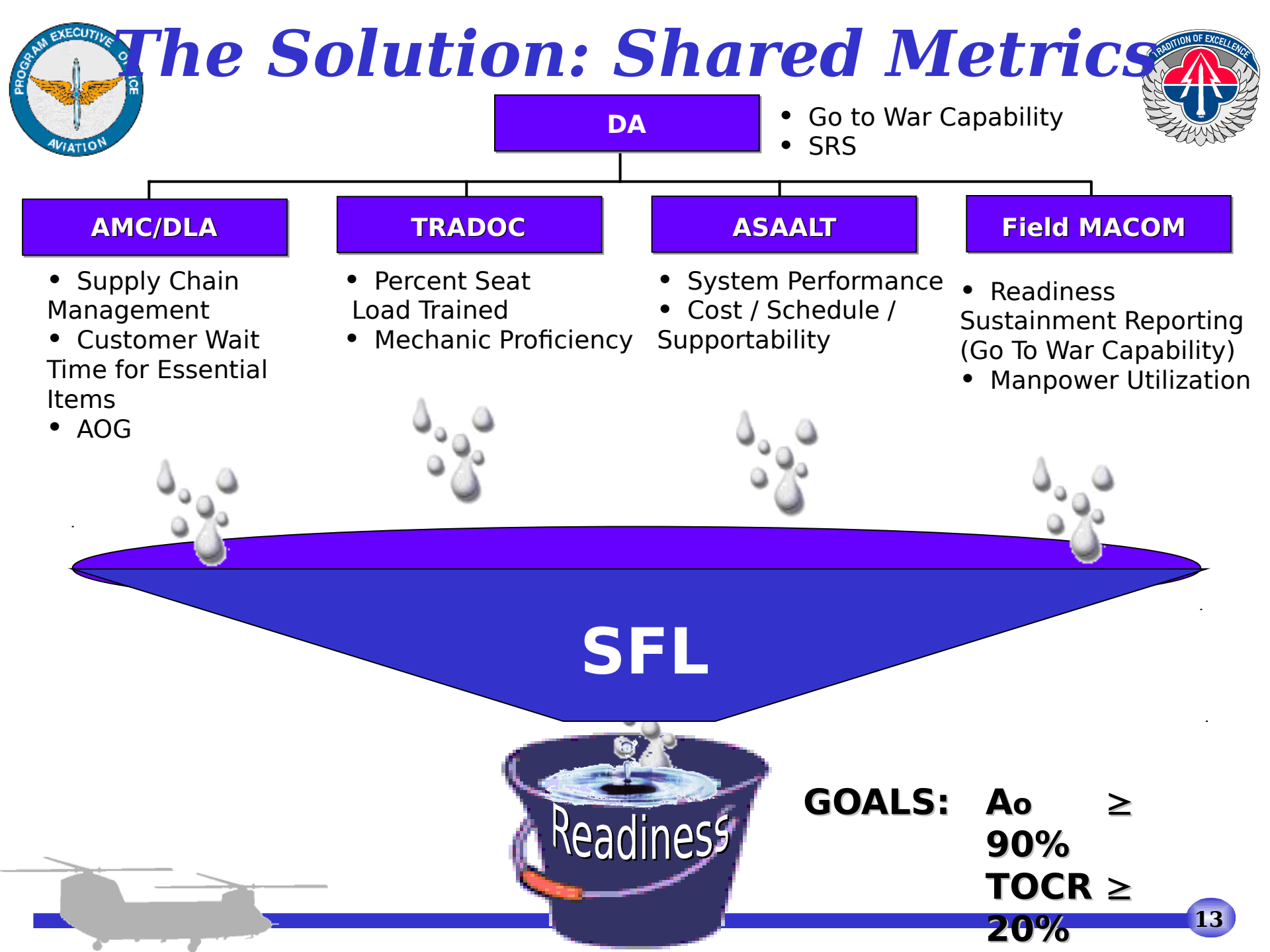
The Problem:



GOALS: $A_o \geq 90\%$
 $TOCR \geq 20\%$

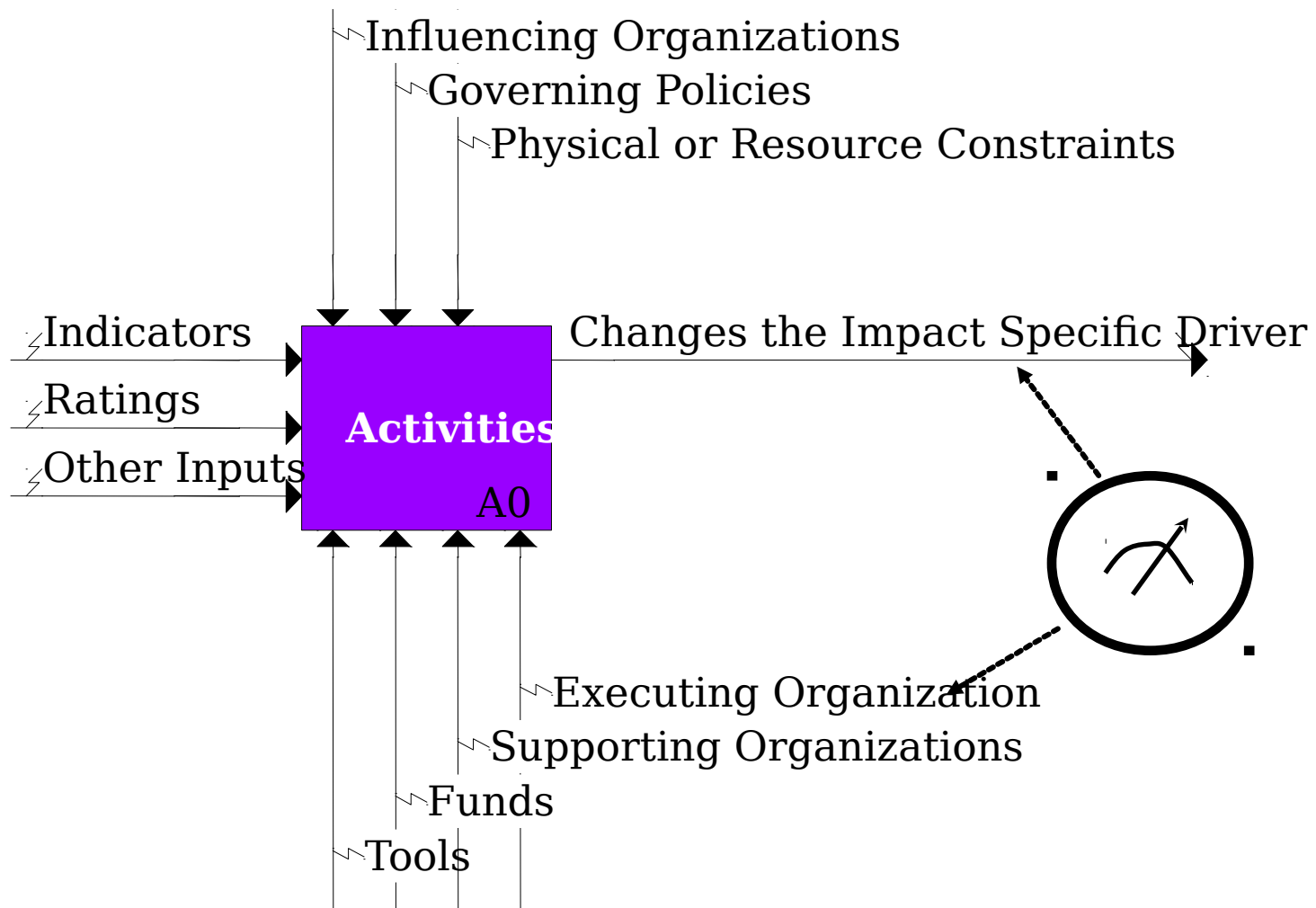


WHAT'S WRONG ? - METRICS!



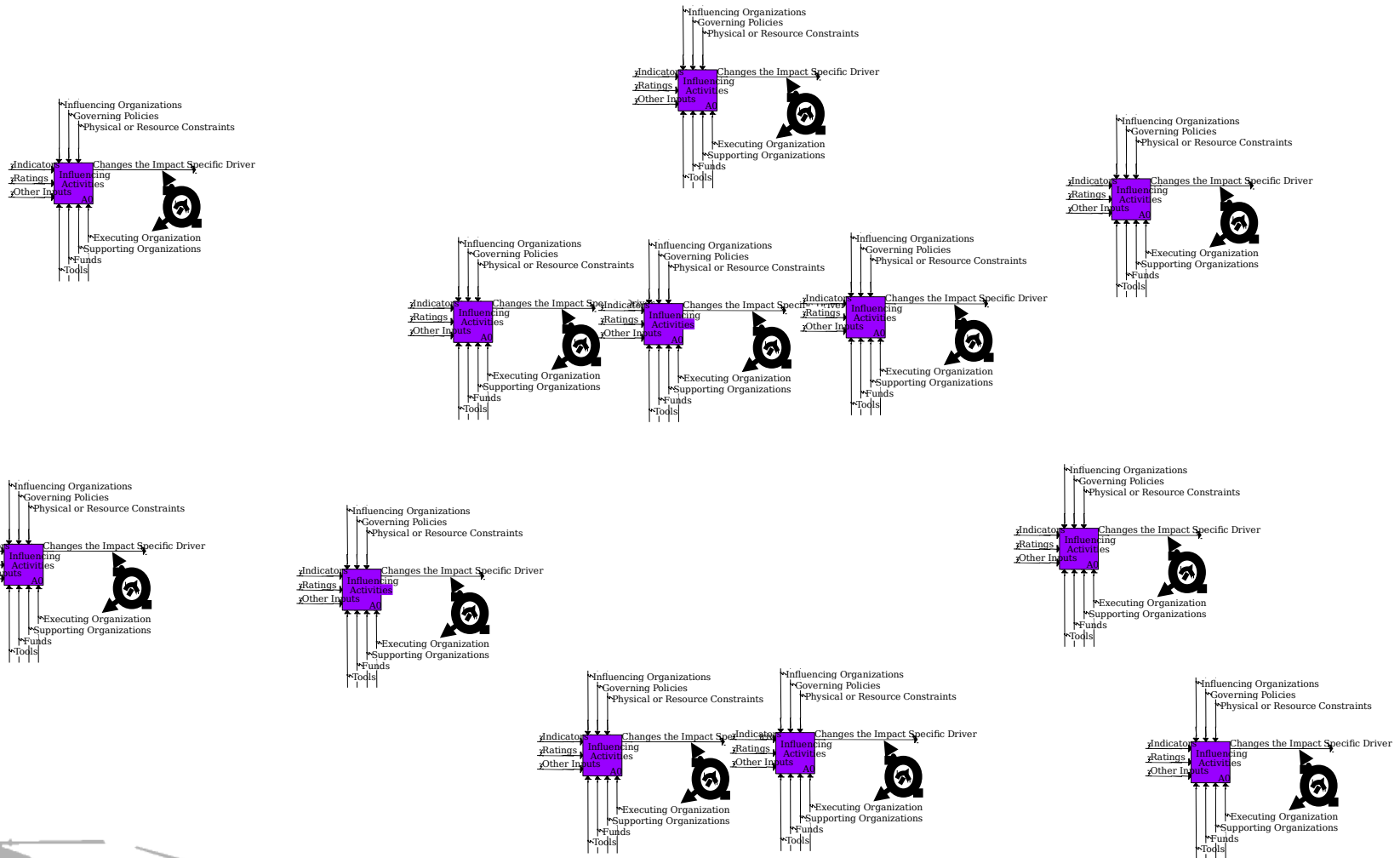


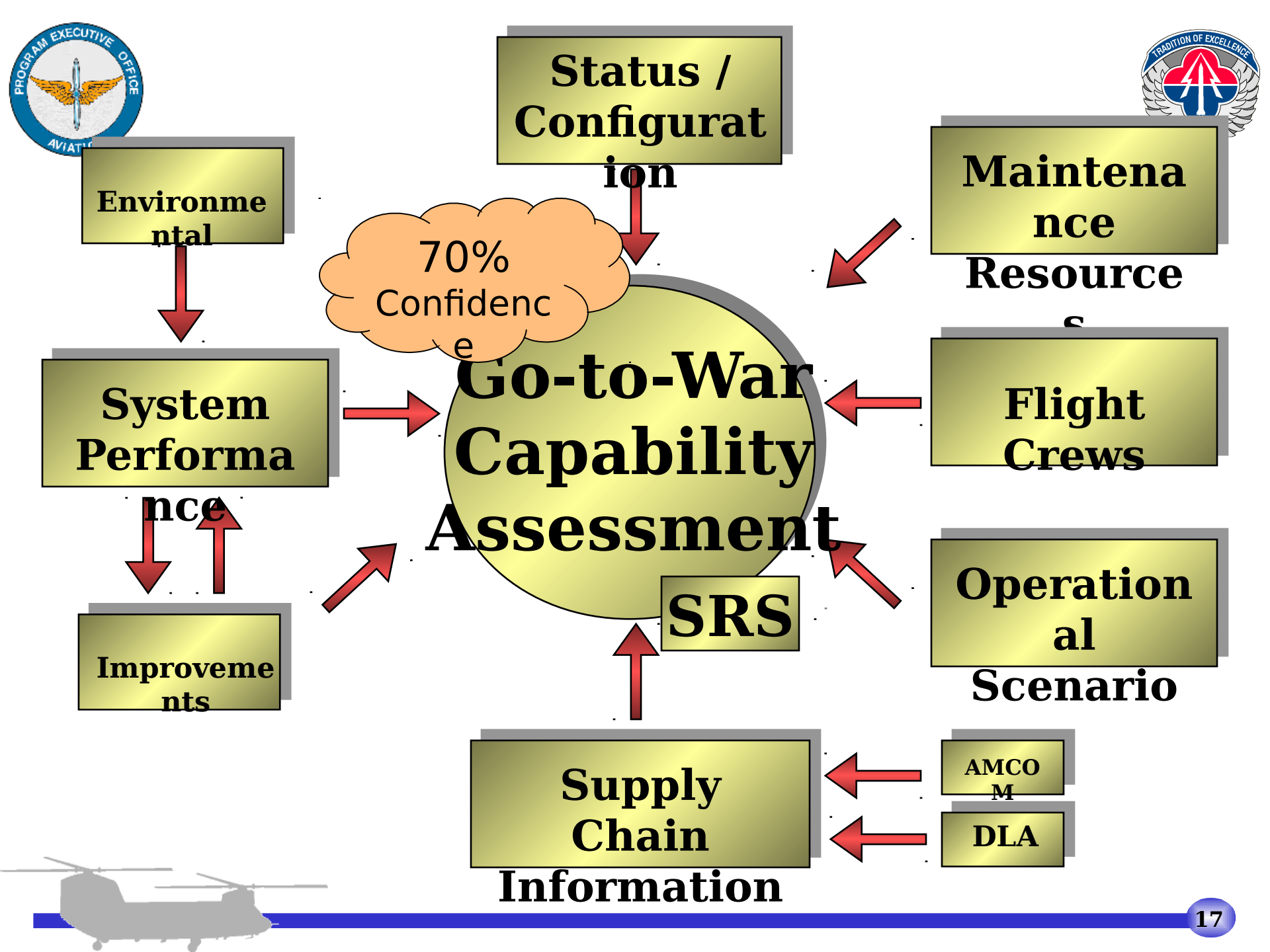
SFL Activity & Process Metrics





SFL Activity & Process Metrics







Six Patterns of Failure

**Bath Tub
curve**

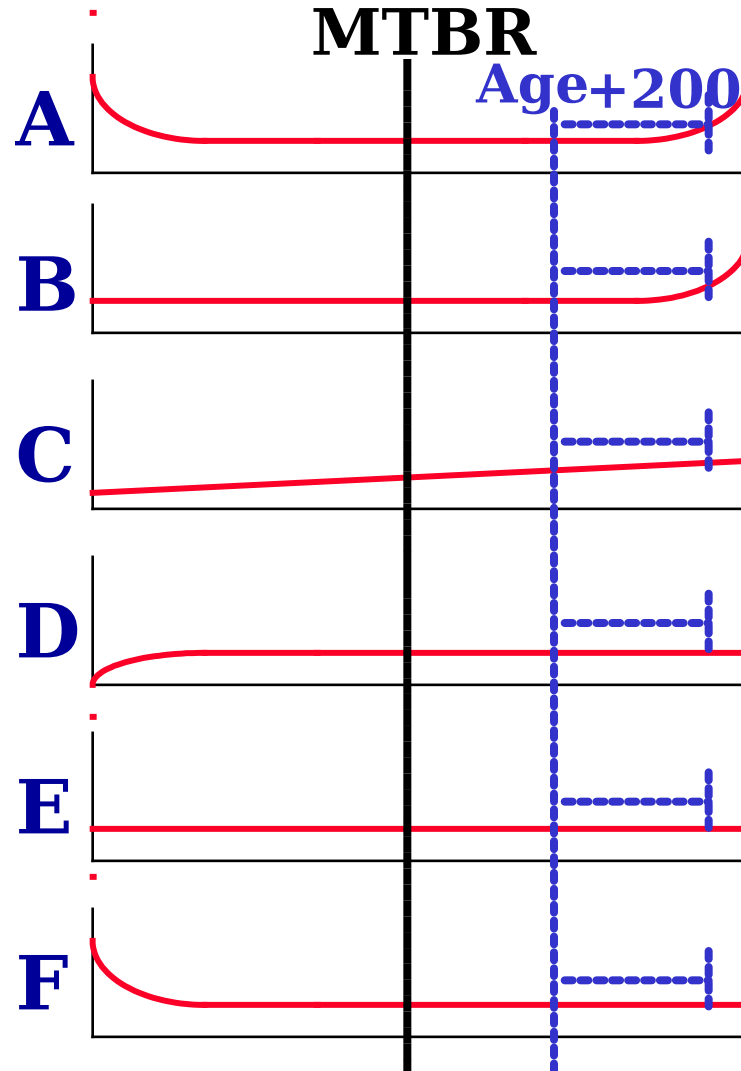
**Slowly increasing
failure rate, then
wear out zone**

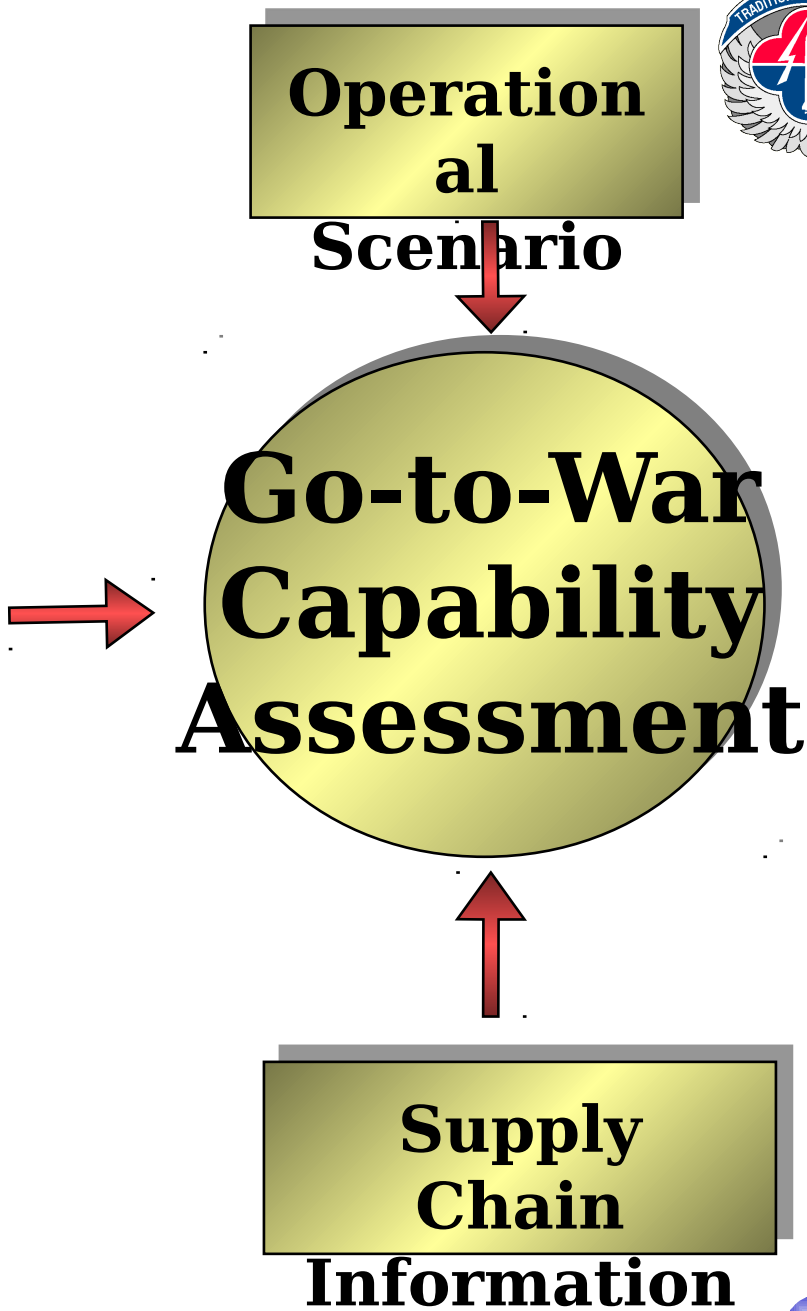
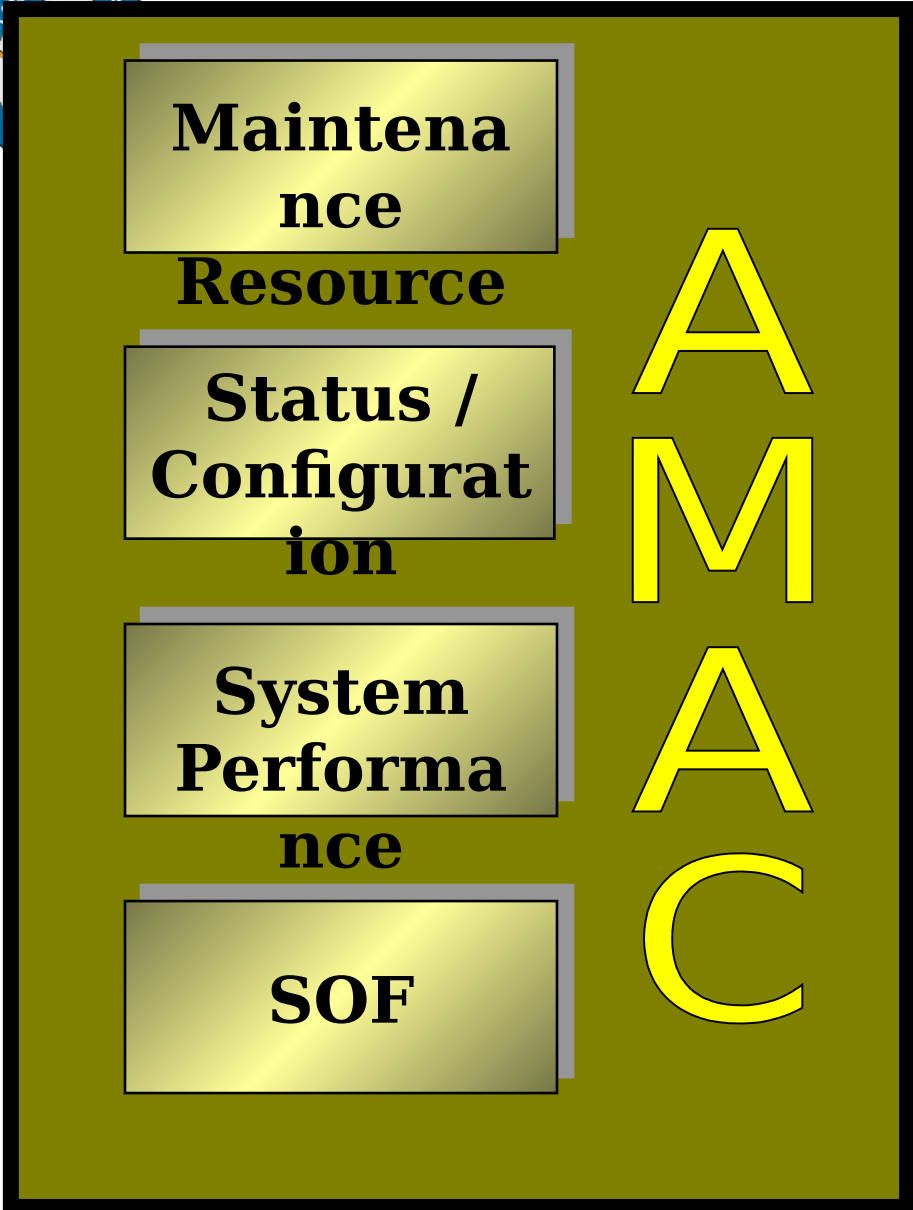
**Steady increase
in probability of
failure**

**Low when new,
then increases to
steady failure rate**

Random

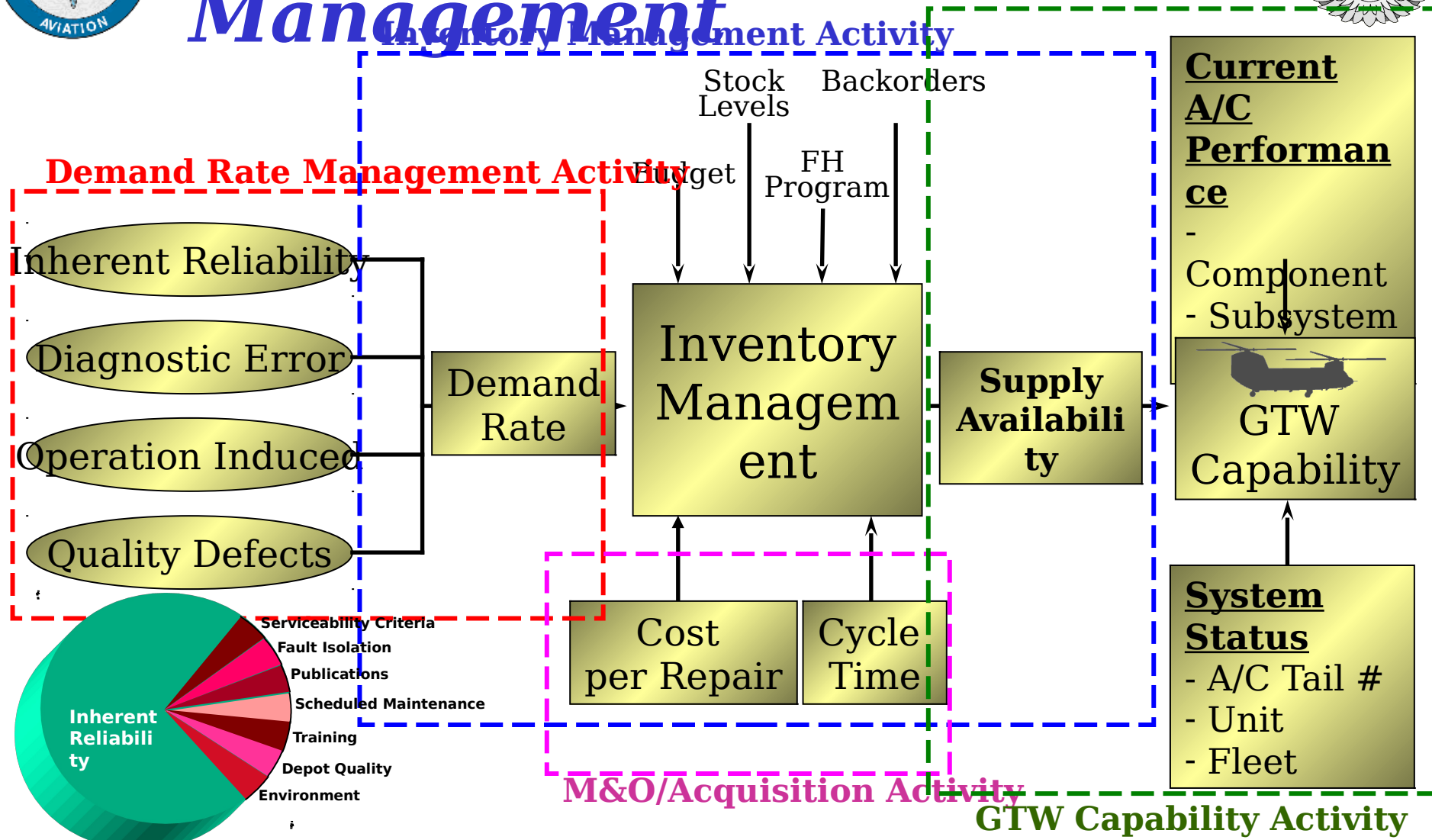
**Infant
mortality, then
random**





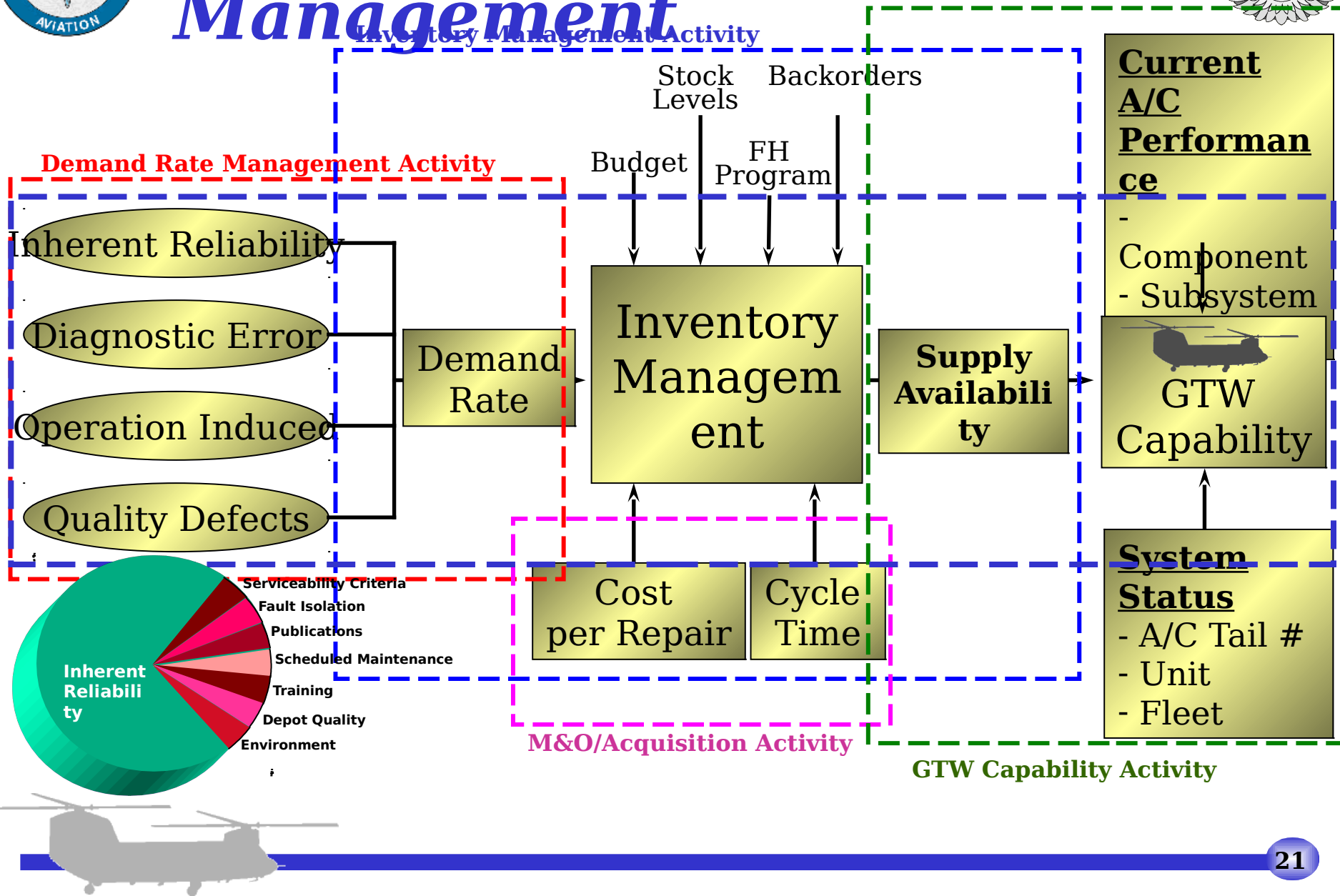


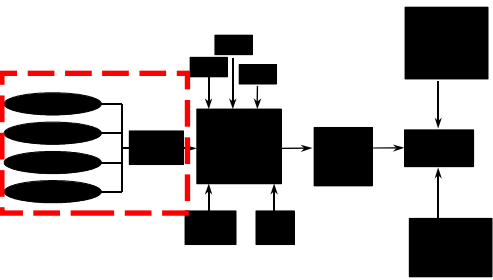
Focus: Inventory Management



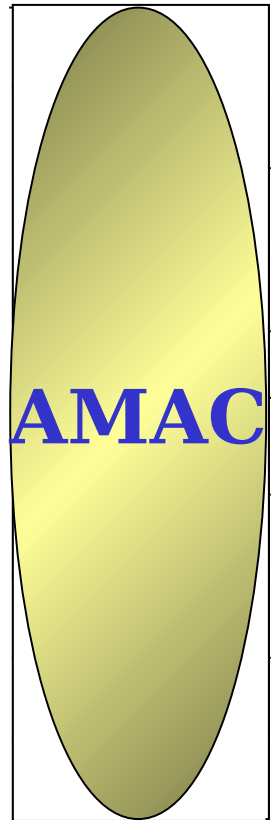


Focus: Inventory Management





Demand Rate Management Activity

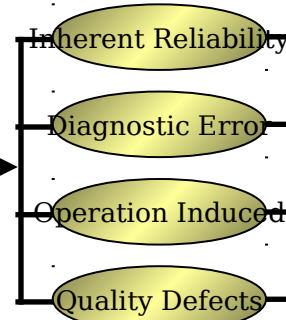


- Data Analysis
- Data Mining
- Metrics

**RCM2
Team
Analysis**

**AMAC
Field
Data**

**AMAC
Depot
Data**



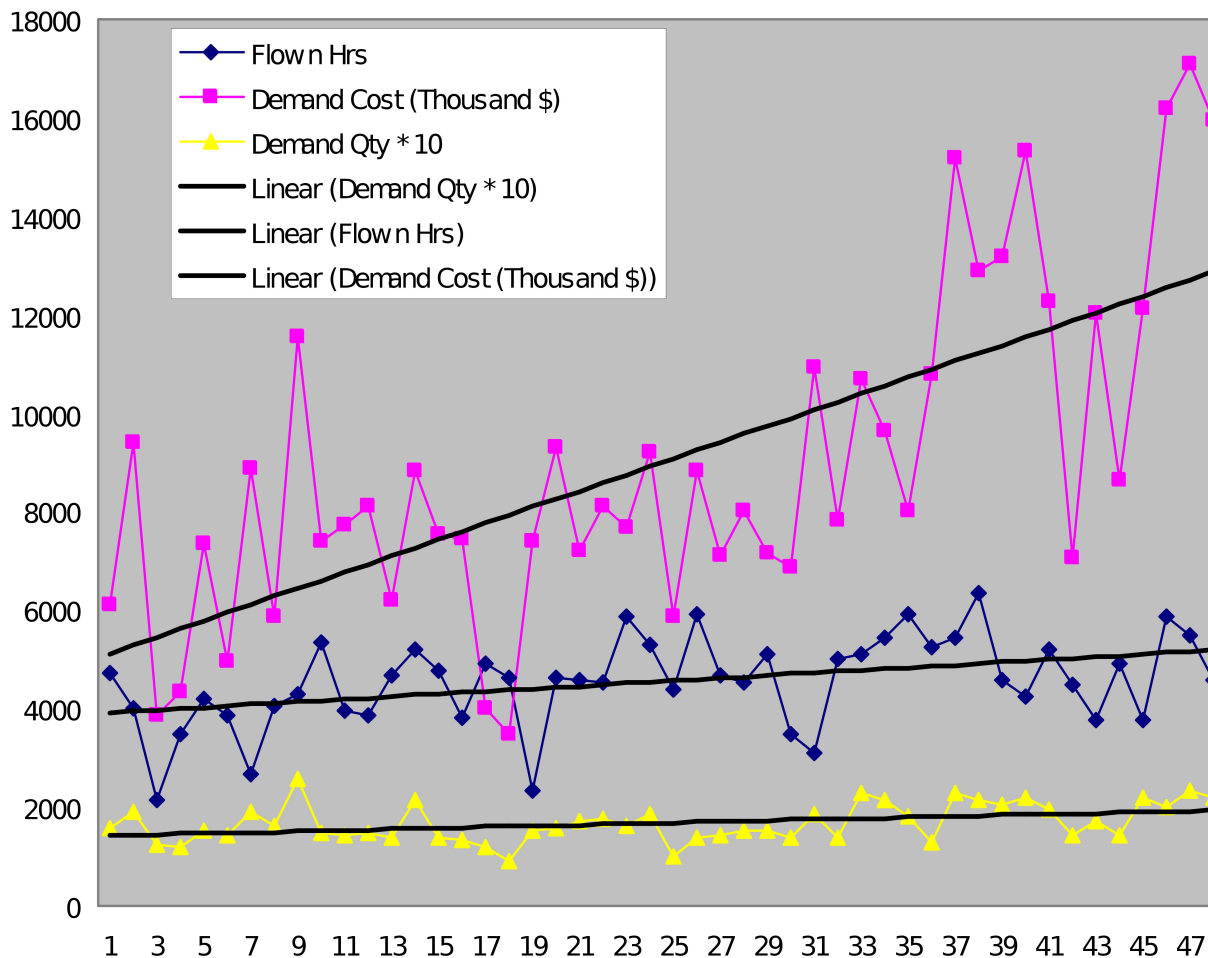
**Demand
Rate Reduction
Opportunities**

DTL
O
M
S



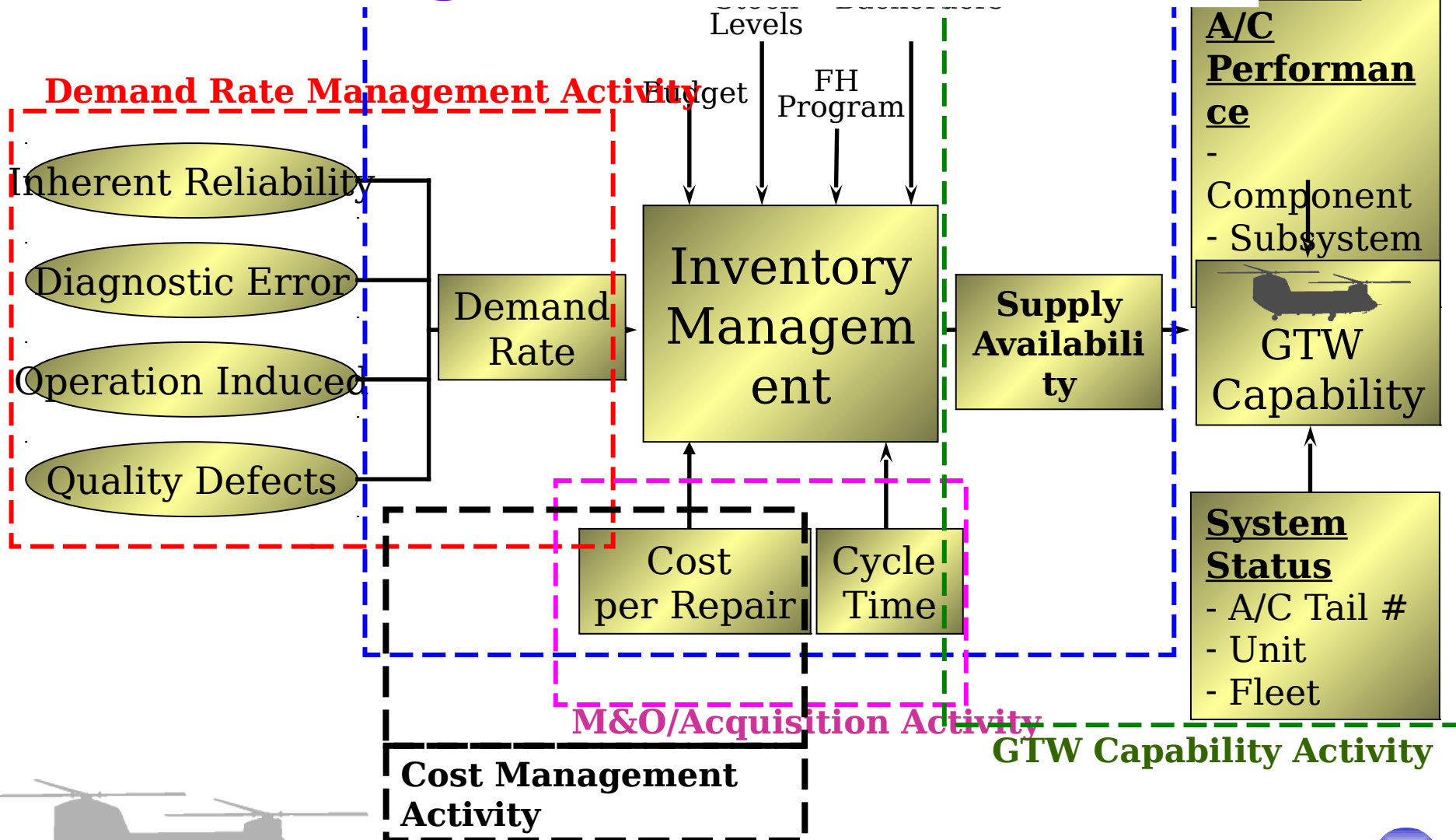


Sample of Cost of Operation Growth over 4 years (7/99-6/03)



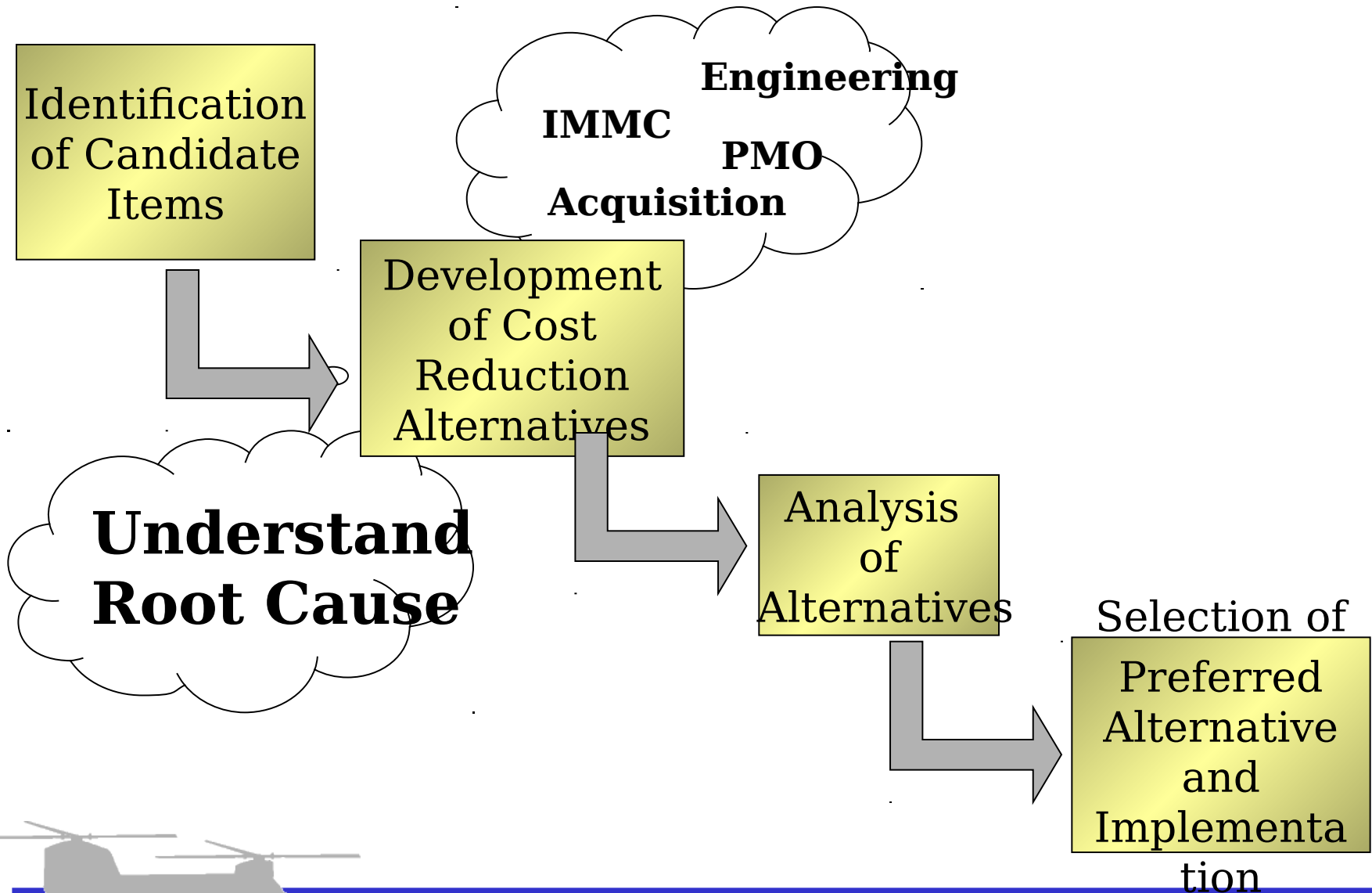


Focus: Cost Management





Cost Management Activity





O&S Cost Reduction



$$\text{Cost} = \sum (\text{Maint Event} * \text{Co})$$





Soldier Focused Logistics



Phase 2 - Organic PBL

- Organic PBL that works within Basic Army Infrastructure (Supply, Finance, Repair, Support).
- Establish Performance Based Agreements.
- Demonstration on a Single Subsystem.



Performance-Based Logistics

A strategy for weapon system product support that employs the purchase of support as an integrated performance package designed to optimize system readiness. It meets performance goals for a weapon system through a support structure based on performance agreements with clear lines of authority and responsibility.





SFL Pilot - T55-GA-714A Engine



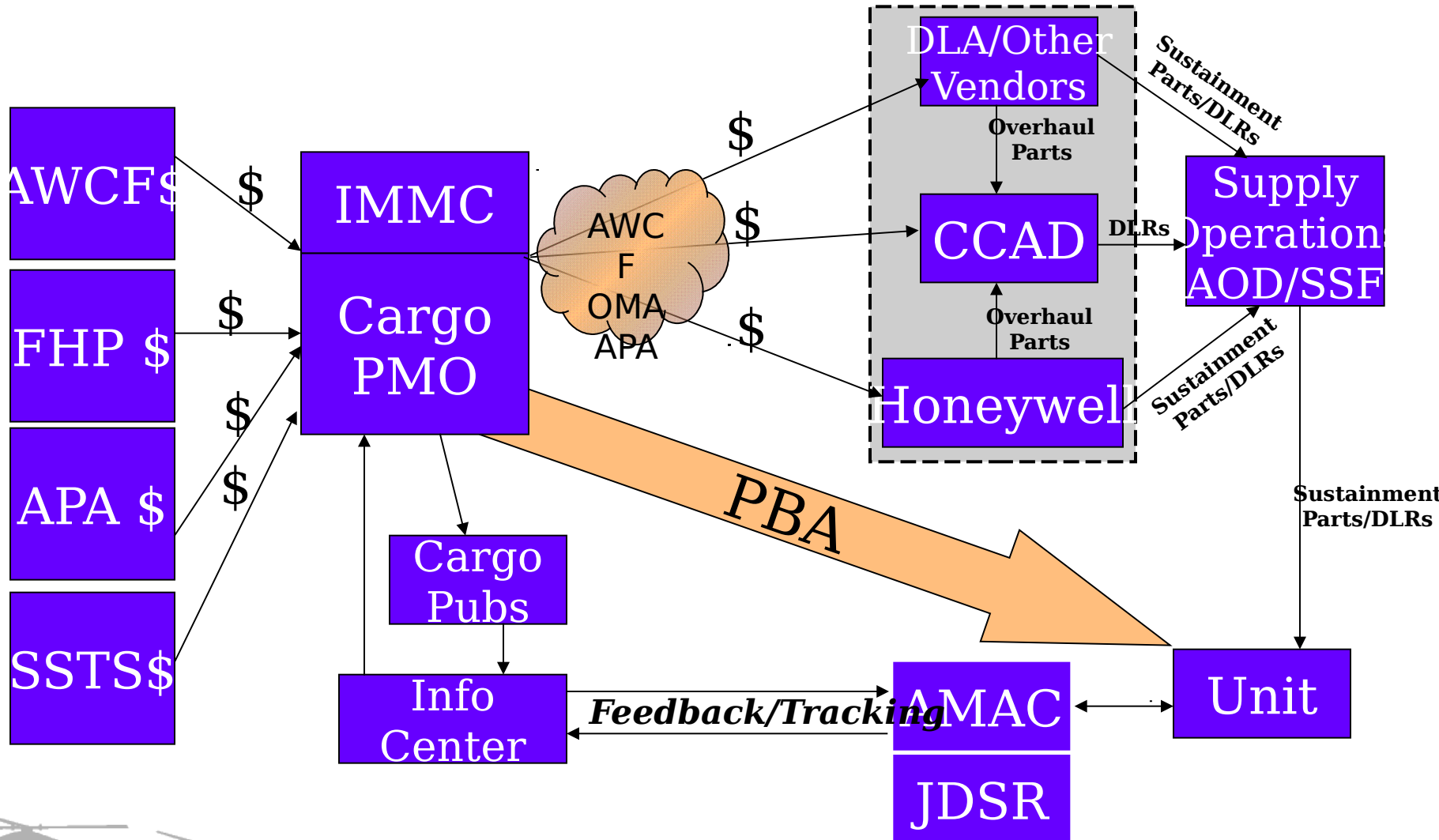
- High cost driver
- Small initial population
 - 400 engines fielded by end of FY 03.
 - Target population of 1100.
 - Approx \$38 M/yr Spare & Repair parts.
- DMWR in process.
- Depot partnership in work.
- Parts catalog contract in place.
- Willing contractors/DLA.
- Significant commercial equivalent base w/AIT.

14 Engine is a Low Risk Pilot





Engine SFL Model



The background of the slide is a photograph of two military helicopters, likely Apache attack helicopters, flying over a rugged, mountainous terrain. The helicopter in the foreground is larger and more detailed, showing its main rotor, tail rotor, and various sensors and weapons. The second helicopter is further back and to the left. The sky is overcast and grey, and the mountains in the background are hazy.

The Significance of RCM2



Agenda



- RCM Process
- Systems Analyzed
- RCM Results and Benefits
- Summary





The Traditional View of Failure

1955: Commercial Airline Industry

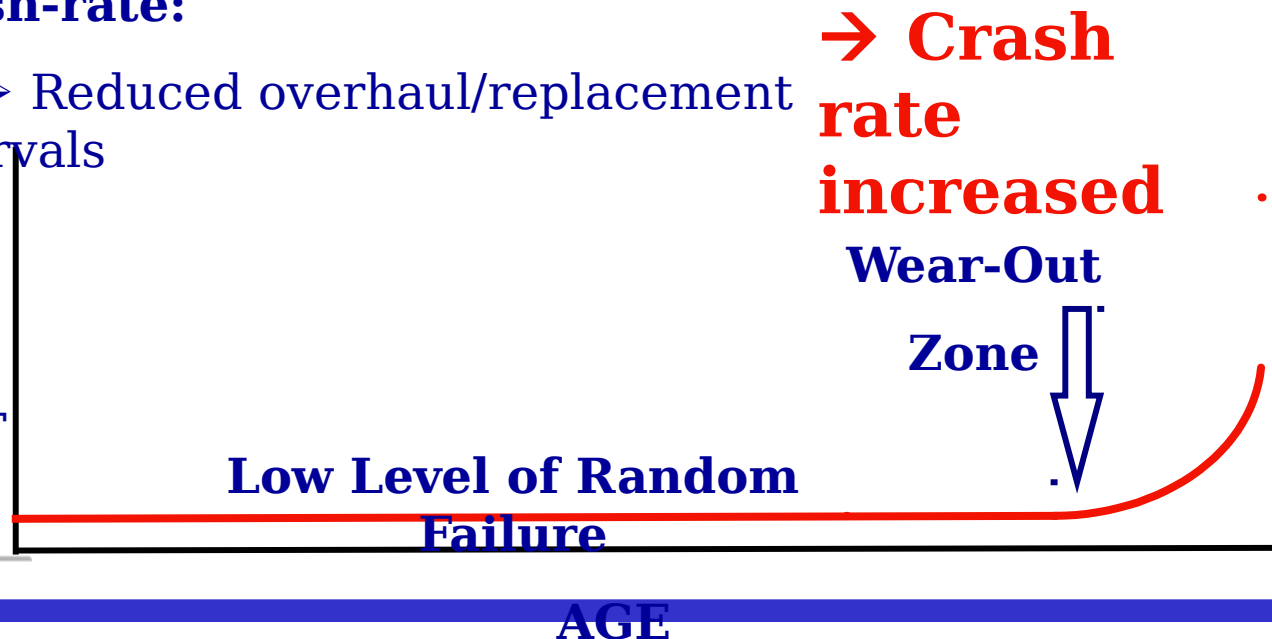
- 85% aircraft components scheduled for overhaul or replacement

Early 1960s: Crash rate ~ 60 crashes/million takeoffs

- 67% of crashes due to component failure
The action taken to decrease crash-rate:

- Reduced overhaul/replacement intervals

**CONDITIONAL
PROBABILITY
OF FAILURE**





Six Patterns of Failure

Stanley Nowlan and Howard Heap: Engineers,
United Airlines

Bath Tub curve

Slowly increasing failure rate, then wear out zone

Steady increase in probability of failure

Low when new, then increases to steady failure rate

Random

Infant mortality, then random

A



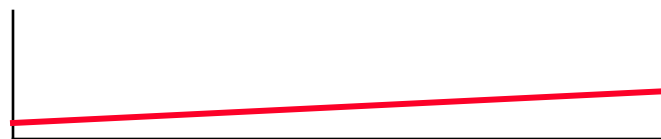
4%

B



2%

C



5%

D



7%

E



14%

F



68%

Simple or complex items that have direct contact with product.
Ex. Tires, Brake Pads, Pumps

Complex equipment.
Ex. Electronics, Hydraulics, Pneumatics



Reliability Centered Maintenance 2

A process used to ensure that any physical asset continues to do whatever its users want it to do.





RCM2 Process

To Develop Justified Maintenance Requirements, the RCM Review Group Answers Seven Questions:

- 1. What are its functions and associated performance standards?**
- 2. In what ways can it fail?**
- 3. What causes it to fail?**
- 4. What happens when it fails?**
- 5. Does it matter if it fails?**
- 6. What can be done to predict or prevent each failure?**



RCM2 Process

1. What are its functions and associated performance standards?

2. In what ways can it fail?

3. What causes it to fail?

4. What happens when it fails?

Questions 1-4: **FMEA**

(Failure Modes Effects Analysis)

5. Does it matter if it fails?

6. What can be done to predict or prevent each failure?

7. What do we do if we cannot prevent the failure?



RCM2 Process

5. Does it matter if it fails? *Considers safety implications of each failure mode first.*

Question 5: CONSEQUENCE ASSESSMENT

- ◆ Hidden
- ◆ Operational
- ◆ Safety/Environmental
- ◆ Non-Operational

6. What can be done to predict or prevent each failure?

7. What do we do if we cannot prevent the failure?



RCM2 Process

6. What can be done to predict or prevent each failure?

Question 6: **PROACTIVE TASKS**

♦ Scheduled On-Condition Tasks } Predictive Maintenance



Application of Condition Based Maintenance (

♦ TBO Items

♦ Retirement Life Items

} Preventive Maintenance

7. What do we do if we cannot prevent the failure?



RCM2 Process

7. What do we do if we cannot prevent the failure?

Question 7: **DEFAULT ACTIONS IF AN APPROPRIATE PROACTIVE TASK CANNOT BE IDENTIFIED**

♦ **Failure Finding Task**

- Check if the item is in a failed state.

♦ **Redesign**

- Physical equipment modification.
- Change in Training, Supply, or Equipment Operating Procedure
- Correction/update to Technical Publications.

♦ **No Scheduled Maintenance**



RCM Review Group



**Tech
Pubs**

Engineer

Test Pilot

**Depot
Artisan**

**Flight
Engineer**

**Equipment
Manufacturer**

**Mechan
ic**



Facilitator





Chinook Systems Completed

- Flight Control System
- -714A Engine/FADEC
- -714A IETM
- Advanced Flight Control System (AFCS)
- Flight Hydraulic System
- Power Train
- Engine Air Particle Separator (EAPS)
- Fuel System





Power of RCM

- **Reengineered Maintenance Schedule**

*Maintenance task is generated
an identifiable and explicit*



- **Simulation Updates**

- **Physical Redesigns**

- **Procedural Redesigns**

- **Training Redesigns**

- **Operational Redesigns**

- **Technical Publication Redesigns**

☆ RCM applied to the Interactive Electronic Technical Manual

- **Demand Rate RCM analysis to be performed**



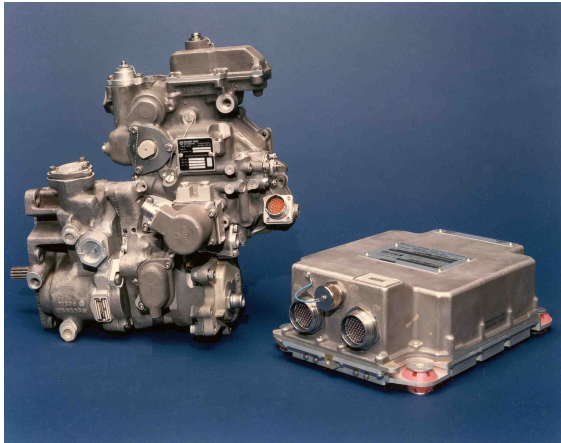
CH-47D RCM2

Recommendations

SYSTEM	RECOMMENDATIONS					
	Physical	Publicatio ns	Training	Operationa l	Procedura l	Simulator
-714A Engine	14	16	3	1	53	0
-714A FADEC	13	18	4	8	17	2
-714A IETM	1	20	0	0	0	0
Flight Control	5	16	2	0	36	0
Flight Hydraulics	2	1	0	2	19	0
Advanced Flight Control System	6	0	0	1	10	0
System Train	8	1	0	1	27	0
EAPS	2	5	0	0	4	0
Fuel System	1	0	0	2	0	0
Total	52	77	9	15	166	2
Implemented	12	15	7	5	13	2
In-progress	37	61	2	10	152	0
Disapproved	3	1	0	0	1	0



Results



- **Improved understanding of Full Authority Digital Electronic Control Unit (FADEC)**

- ⇒ Developed an accurate and useable pilot fault code matrix
- ⇒ Identified that simulator does not accurately replicate FADEC failures under certain conditions

- **Capitalized on -714A technology to increase readiness and reduce mission aborts**

⇒ Established correct emergency and operating

Summary

“We’re making a big difference here.”

“...elevating weaknesses, errors, and deficiencies...”



“This is worth a zillion dollars if we can get this information out.”

“It is a direct interface between us and the manufacturer.”

“It gives the users a voice.”

“I want to know why we aren’t as good as we think we are and I want to know how we can

Nancy Regan
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617-921-5408

